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13. ABSTRACT (Maximum 200 words)  Collection, reduction, and analysis of ocean finestructure and microstructure profiles about Fieberling Guyot, a seamount in the northeast Pacific Ocean, formed the core of research supported by grant N00014-89-J-1073. Our research, carried out in collaboration with Dr. Eric Kunze, U. Washington, focused on developing understanding of turbulent mixing associated with flow about major bathymetric features, and as such, contributed to the Topographic Interactions Accelerated Research Initiative. The intensified mixing documented at Fieberling Guyot suggests that near-rough-bottom regions of the ocean are key to closing the cold-to-warm limb of the meridional overturning circulation. Above the seamount summit, intense mixing was found, associated with a tidally forced, diurnal period internal wave trapped to an anticyclonic vortex. Enhanced mixing was also observed above the rough flanks of the seamount: the product of instability within an internal wave field distorted by bottom reflection and/or bottom wave generation. In contrast, at distances more than 15 nmi from the seamount, the internal wave field was at climatological level and the turbulent mixing was weak at all depths sampled (to 3000 m). These results were synthesized by testing and extending models that relate the internal wave field to the turbulent dissipation.				
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## Summary of Research

Observations of ocean velocity, temperature, salinity and turbulent dissipation rates of kinetic energy and thermal variance, were made during a research cruise aboard the R/V New Horizon in March, 1991. The WHOI team operated the High Resolution Profiler (Schmitt *et al.*, *J. Atmos. Oceanic Tech.* **5**, 484-500, 1988). We were joined by Dr. Eric Kunze, who employed expendable velocity and temperature probes (XCP's, XBT's). Focus of our study were the flows about Fieberling Guyot, a seamount in the northeast Pacific Ocean that reaches from background depths of 4500-5000 m to within 500 m of the surface. The characteristics of the ocean finestructure and microstructure varied markedly with position relative to the seamount. Major results and resulting scientific papers are summarized below.

### 1. Far-field

At distances greater than about 15 nmi from the seamount, the internal wave field was at climatological level and the turbulent dissipation rates for kinetic energy and thermal variance were small. Diapycnal diffusivities inferred from the latter were about  $0.1 \times 10^{-4} \text{ m}^2 \text{ s}^{-1}$ , an order of magnitude smaller than have been inferred from an advective-diffusive balance for the main thermocline and from heat budgets for abyssal waters in semi-enclosed basins. Our observations were notable for reaching 3000 m depth and buoyancy stratifications,  $N^2 \approx 10^{-6} \text{ s}^{-2}$ . Previously, researchers had theorized that the background internal wave field supports greater intensity mixing at weak stratification than it does in the main thermocline. Our observations indicate that it does not.

Toole, J.M., K.L. Polzin and R.W. Schmitt, Estimates of diapycnal mixing in the abyssal ocean. *Science*, **264**, 1120-1123, 1994.

### 2. Seamount summit

Intense horizontal currents with small vertical scales ( $\sim 100 \text{ m}$ ) were sampled above the summit of Fieberling Guyot. The time-mean circulation was characterized by an anticyclonic (clockwise) circulation with peak speed of  $\sim 15 \text{ cm s}^{-1}$  at the seamount's rim. Inside this radius, the flow was in approximate solid body rotation. The anticyclone, that extended up from the bottom some 200-300 m, has a significant potential vorticity anomaly, incontrovertible evidence that tidal rectification is an important driving mechanism. Imbedded within the anticyclone

were diurnal motions with vertical wavelength comparable to the scale of the vortex. These motions are believed to be tidally forced free internal waves, trapped to the zone of negative relative vorticity formed by the vortex. (Diurnal motions are sub-inertial in a resting ocean at the latitude of Fieberling Guyot.) These so-called vortex trapped internal waves are reflected at the horizontal edges of the anticyclonic circulation, and encounter a critical layer at the upper boundary of the vortex. Large shears, supporting intense turbulent dissipation, characterize the critical layer approach of the vortex-trapped waves. The diapycnal mixing that results above this seamount's summit is comparable to that experienced in an ocean interior area that is 250 times greater.

Kunze, E. and J.M. Toole, Tidally-driven vorticity, diurnal shear and turbulence atop Fieberling Seamount. *J. Phys. Oceaogr.* accepted, 1997.

### 3. Seamount flank

Compared to the ocean interior, finescale shears and strain were enhanced above the steep, rough flanks of Fieberling Guyot. These led to greater occurrence of low Richardson number: the resulting instabilities believed responsible for enhanced turbulent dissipation near the seamount flanks. Greater relative increase in strain compared to shear is consistent with high-frequency internal waves, as might be produced by near-critical bottom slope reflection. Presence of bottom-generated wave energy was also indicated. Together, these findings support Walter Munk's idea that near-boundary mixing plays a major role in the "abyssal recipe."

Toole, J.M., R.W. Schmitt, and K.L. Polzin, Near-boundary mixing about the flanks of a midlatitude seamount. *J. Geophys. Res.*, **102**, 947-959, 1997.

4. Relationships between internal waves and turbulent dissipation  
Data collected about Fieberling Guyot also contributed to understanding of internal wave-wave interactions and their connections to dissipation and mixing. Our observations were best explained with an extension to the strong wave interaction model of Henyey *et al.*, 1986, in which dissipation rate is predicted to scale with  $S^4N^2$ , where  $S$  is the spectral level of the finescale shear energy density, with a secondary correction for the internal wave frequency content. This work represents a major step forward towards a developing global estimates of the intensity of turbulence and mixing in the oceans.

Polzin K.L., J.M. Toole and R.W. Schmitt, Finescale parameterizations of turbulent dissipation. *J. Phys. Oceanogr.*, **25**, 1995.

Polzin, K.L., Observations of turbulence, internal waves and background flows: An inquiry into the relationships between scales of motion. Ph.D. dissertation, MIT/WHOI Joint Program in Oceanography, Tech. Rep. No. WHOI-92039, 244 pp, 1992.